Synthesis and chemical investigation of $Sg(CO)_6$*

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Gas phase chemical studies of the superheavy elements have been limited to simple inorganic compounds so far [1]. Due to challenging experimental conditions, access to other compound classes was limited. With the combination of physical preseparation and gas-phase chemistry, many limitations could be overcome [2,3]. We succeeded in the synthesis of a carbonyl complex of a superheavy element - seaborgium hexacarbonyl ($Sg(CO)_6$), at the GAs-filled Recoil Ion Separator GARIS [4]. $Sg(CO)_6$ has been predicted to be stable [5] and its adsorption behavior on a SiO_2 surface is expected to be very similar to that of $W(CO)_6$ [6]. Thus, we investigated $Sg(CO)_6$ along with $W(CO)_6$. 6-s ^{164}W, and $\approx$ 10-s ^{265}Sg were synthesized in the reactions ^{144}Sm(^{24}Mg,4n)^{164}W and ^{248}Cm(^{22}Ne,5n)^{265}Sg. Evaporation residues (EVRs) were separated from the primary beam and lighter transfer products within GARIS. At the focal plane of GARIS, a recoil transfer chamber (RTC) was installed. The EVRs passed the entrance window of the RTC and were thermalized in a He / CO atmosphere ($\approx$ 600 mbar) in the RTC. The free single ions of W and Sg reacted with CO, forming volatile complexes [7]. The RTC was flushed continuously, transporting volatile compounds through a 10-m long capillary to the Cryo Online Multidetector for Physics and Chemistry of the Transactinides COMPACT [8], a thermochromatography detector array. The chromatography channel is formed by 32 pairs of silicon PIN diodes covered with a SiO_2 surface, kept at temperatures between $22°C$ and $-140°C$. Volatile compounds adsorb at a certain temperature on the detector surface. The deposition pattern was compared with Monte Carlo Simulations MCS, which allowed determining the adsorption enthalpy $-\Delta H_{ads}$. W and Sg were transported to COMPACT, hence formed volatile compounds with the CO [7]. In total, 15 decay chains assigned to the decay of ^{265}Sg plus three uncorrelated fission event assigned to the decay of ^{261}Rf as a daughter of ^{265}Sg were observed under background-free conditions. The total beam integral was $1.52 \cdot 10^{19}$. Both, the W and the Sg complexes deposited mainly in the last third of the detector (see Fig. 1). The Sg species show the same adsorption behavior as $W(CO)_6$, which supports the assignment to $Sg(CO)_6$ [7]. The experimental distributions and the MCS are shown in Fig. 1.

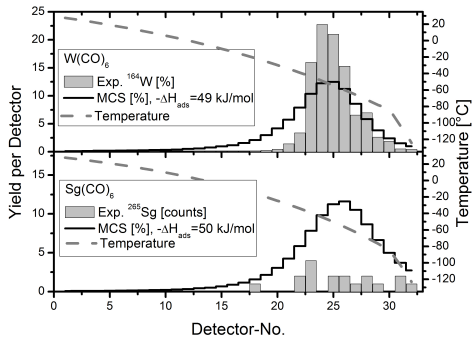

Figure 1: Distribution of ^{164}W and ^{265}Sg in the COMPACT detector array. The bars show the experimental distributions, the solid lines show the results from MCS. (after [7]).

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